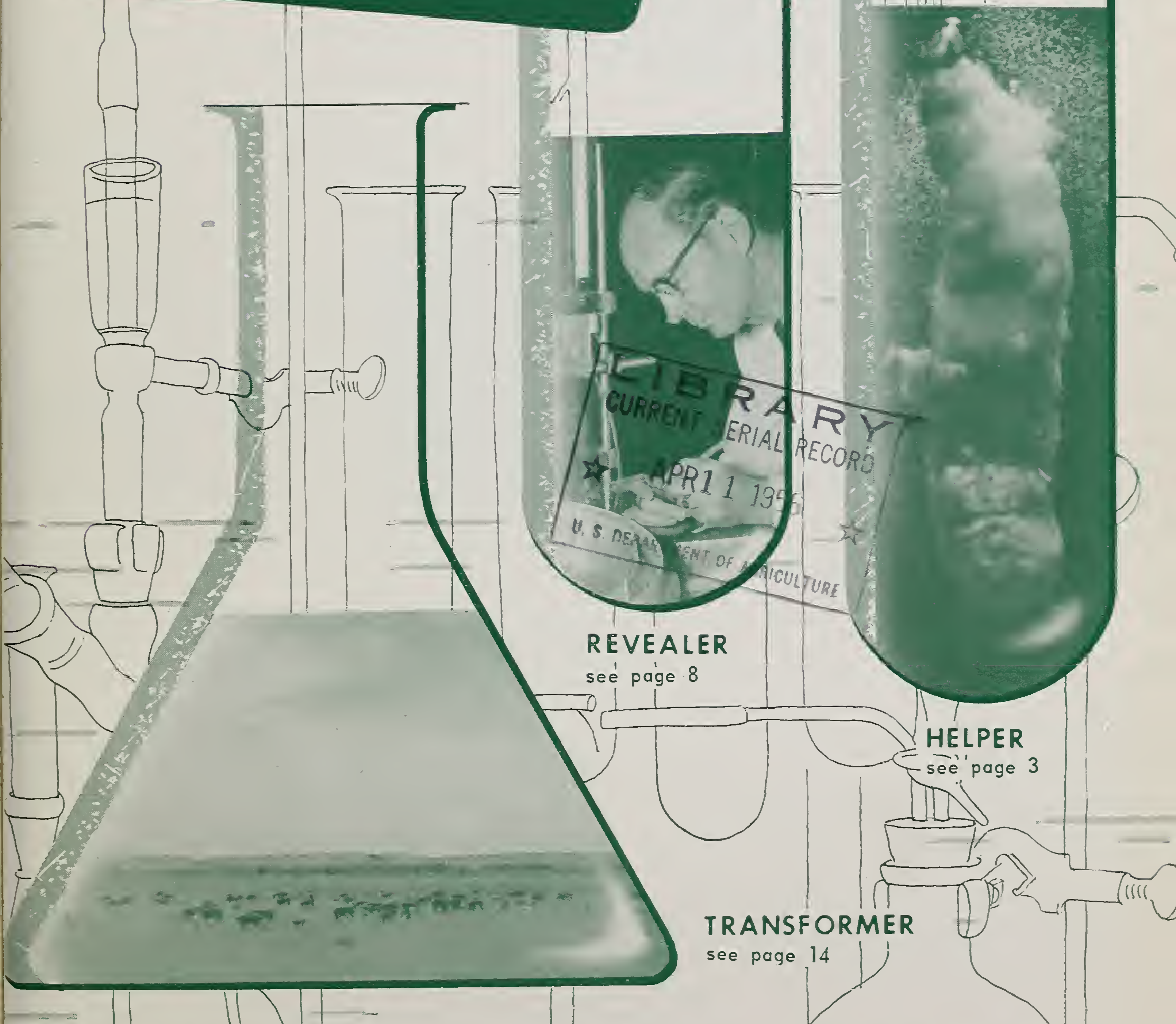
AGRICULTURAL Research

APRIL 1956



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UNITED STATES DEPARTMENT OF AGRICULTURE

AGRICULTURAL
Research

Vol. 4—April 1956—No. 10

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New uses

New uses for crop and livestock products—*there* is another big opportunity for agricultural research to help farmers today (see "Cost cutting," Agr. Res., March 1956, p. 2).

Take wheat. Last year's restricted production of some 938 million bushels is nearly in line with demand. But we still have a billion-bushel stock on hand. It's costly to store and hangs over the market to depress the price of the new crop.

Suppose we developed new industrial outlets for wheat. Think what that could mean. We could empty the storage bins and use advancing technology on all our productive acres.

We need to learn from industry itself—to study our farm commodities as raw materials. That's how the petroleum industry has made gasoline, perfumes, medicines. insecticides. and hundreds of other useful products from a barrel of oil.

First step to new uses for wheat is to get a clear idea of what's in the kernel. That's not easy. We know a lot about wheat, but chemists tell us that more than a hundred of its constituents are not yet fully understood. Science is giving us new tools for getting this information. (See p. 8.)

As we increase our livestock industry, there will be increasing markets for feed. We need to know more about the nutritional factors of wheat as well as our other cereals.

One of the important gains in livestock nutrition came in the discovery of the growth factor vitamin B_{12}. About half the B_{12} on the market is made through fermentation of corn by methods developed in utilization research. This suggests a search for microorganisms that feed on wheat and produce certain amino acids essential to livestock but lacking in wheat. These amino acids would then be added to the wheat.

Of course, bread will still be the chief market for wheat. The baking industry tells us that one of the main obstacles to selling more bread is staling—the second half of a loaf doesn't go as fast as the first half. New developments in freezing and packaging suggest new approaches to this matter.

Those are some of the possible new outlets for wheat. Opportunities for utilization research are equally promising for other commodities. We are doing something about them.

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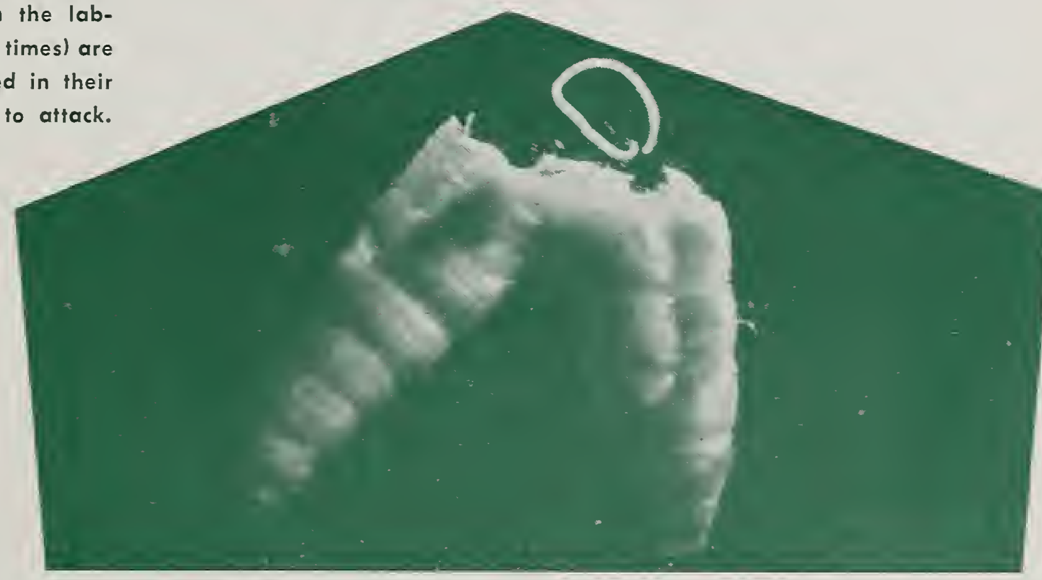
AGRICULTURAL RESEARCH SERVICE
United States Department of Agriculture

THOUSANDS of tiny, eel-like organisms are nematodes emerging normally from a cadaver of a wax-moth larva. Each cadaver will produce about 150,000 of the beneficial organisms, which are easily reared in the laboratory. Nematodes shown (enlarged about 4 times) are second-stage larvae. They will live protected in their armor-like sheaths till they find a new host to attack.



ONLY A FEW infective-stage larvae of the beneficial nematode—the tiny white lines—are present when infected wax-moth larva is prematurely dissected. The big nematode is a female that would normally produce about 500 to 1,000 larvae.

RESEARCHERS SEE INSECT-CONTROL POSSIBILITIES IN THIS DISEASE-CARRYING

Nematode on Our Side

RESEARCH has turned up a beneficial nematode that attacks insects. USDA entomologists believe they may be able to make practical use of it in pest control because:

- It carries an associated bacterium that quickly kills many insects.
- It has high resistance to chemicals, making it compatible with current insecticide and fungicide use.
- It is hardy. It can live for months when no host insect is available, and can survive the shearing of high-pressure spray nozzles.
- So far, it has not been found harmful to plants, man, or animals.

Of the family Steinernematidae, this nematode was discovered by ARS insect pathologist S. R. Dutky in the fall of 1954. It was inside bacterially diseased codling-moth larvae sent to him by W. S. Hough of the Virginia experiment station. Dutky recognized the bacteria found in the codling-moth larvae as similar to those associated with nematodes that were once reared as possible control agents for the Japanese beetle.

The disease has proved deadly not only to codling moths but to at least 35 other insect species, including the corn earworm, boll weevil, pink bollworm, vegetable weevil, cabbage worm, and white-fringed beetle.

The disease is primarily a bacterial septicemia (blood poisoning) carried by this specific nematode. The bacterium doesn't infect insects readily when ingested, but the nematode acts as a microsyringe to introduce the bacterium into the insect's body cavity. The bacterium not only kills the insect but also serves as food for the nematode. Further, the bacterium produces an antagonistic substance (antibiotic) that restricts the bacterial microflora of the killed insect; this protects the cadaver from

decay that would interfere with the nematode's development.

The infective stage of the nematode is the ensheathed second-stage larva. These larvae, encased in their armor, can survive for months in the absence of a suitable host and food. The infective-stage larvae seek out the host insect, enter usually through the insect's mouth, penetrate the insect's intestinal wall, discard their sheaths, and inject bacteria. This sets up the septicemia that kills the host—usually within 24 hours. These exsheathed larvae then feed on the bacteria and reproduce, and the young nematodes emerge from the dead host ready to attack a new host.

Migrating over a moist surface, infective-stage larvae can move considerable distances in search of a host insect. When humidity is high, the larvae can move over dry areas by forming their own films of water. This need for moisture may limit their ability to control insects that feed on the exposed portion of plants but is partially offset by their habit of staying in the host cadaver until free water becomes available. Thus, the cadaver furnishes a place of survival for infective-stage larvae under dry conditions. In the laboratory, nematode larvae were kept alive in partially dried cadavers up to 2 months. The larvae migrate from these insect cadavers within a matter of minutes after they are placed in water.

Test with a variety of insecticides—chlordane, DDT, endrin, lindane, methoxychlor and toxaphene—proved the enshcathed larvae to be quite resistant to chemicals. Few if any were killed when maintained in a water-insecticide suspension for 7 days. They can be kept without injury for an indefinite period in a $\frac{1}{20}$th-normal potassium-hydroxide solution. Their resistance to mineral acids is somewhat less than to alkalis. In a $\frac{1}{20}$th-normal hydrochloric-acid solution, the nematodes survived 5 hours exposure but were all dead in 15 hours. They are sensitive to the elemental halogens; iodine is most toxic, chlorine less toxic, and bromine least toxic of the three.

In spite of their delicate appearance, the ensheathed nematode larvae in water generally survived forcing through various sizes of nozzles on conventional spray equipment.

A method for mass propagation of the nematodes on a scale adequate for field trials has been worked out at the Agricultural Research Center, Beltsville, Md. They are reared in wax-moth larvae (a beehive pest). Each larva yields about 150,000 nematodes, which can be maintained in the host's body or in jars of pure water that are refrigerated or aerated. An artificial medium of Pablum, honey, glycerin, and water is used to propagate the wax-moth larvae. When mature, they can be stored up to a year with small losses.

Last year, over a billion infective-stage nematode larvae were raised for field tests with several crops and several destructive insects. In some of these tests, carried on in cooperation with Hough in Virginia apple orchards, results indicate that 60 to 70 percent control of codling moths may be possible with the nematode-borne disease. Nearly the same degree of control of the corn earworm was achieved in Beltsville tests.

The nematodes have proved hardy to unseasonable hot and cold but are most active as control agents when temperatures are moderate (60° to 80° F.). At 75° and 86° F., the cycle from infective stage to infective stage is 8 days. At lower temperatures, the cycle lengthens.

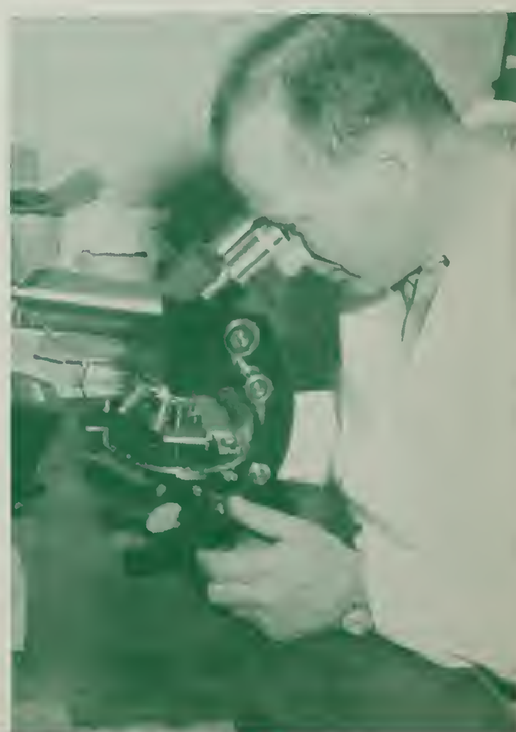
These nematotes can migrate within a matter of hours into the center of tightly headed vegetables and remain alive for long periods, eliminating the necessity of a host.

In one penetration test, outside leaves of several heads of iceberg lettuce, already infested by 50 wax-moth larvae, were each inoculated with 5 drops of nematode suspension (a dosage of 15,000 infective-stage nematodes per head). Three days later, 42 of the wax-moth worms were dead of nematode infection.

The test results with codling moth on apple trees and corn earworm on field corn suggest that this nematode can fulfill in the field the promise indicated in laboratory studies.☆

TRAPPING beneficial nematodes, scientist S. R. Dutky puts wax-moth cadavers on this filter paper covering petri dishes. As the nematodes emerge, they crawl over the paper and down into the water surrounding dishes.

COUNTING nematode "noses," Dutky calculates dosages of the microscopic worms for various tests. In the field tests run last year, these nematodes looked promising as a weapon against several destructive insects.



FOR POOR-LAND CORN: NITROGEN

■ Fertilizing with nitrogen will give a good boost to corn on the less-productive irrigated soils in Nebraska. USDA-State research shows, however, that the amount of gain will depend on several factors.

In the first place, the less available nitrogen there is in the soil, the greater will be the gain in yield from adding chemical nitrogen fertilizer. This showed up in a cooperative study by ARS and the Nebraska experiment station, at Mitchell. During relatively poor growing seasons, additions of 40, 80, and 120 pounds of nitrogen per acre raised yield only 9, 5, and 7 bushels, respectively, on moderately productive soil, but raised it 18, 19, and 24 bushels on a soil having a naturally low productivity limit.

Moreover, corn must have a good growing season to use applied nitrogen fully. On poorer soil, applications of 40, 80, and 120 pounds of nitrogen boosted corn yield 33, 54, and 71 bushels, respectively, in good seasons, but only 18, 19, and 24 bushels in a cool, wet summer.

Not all the benefit from nitrogen applied to a corn crop is gained in the first crop. Quite a nitrogen residue remains for the crop produced in the following year. But the nitrogen is used to fullest advantage only if there are good growing conditions during the year when the fertilizer is applied. Good weather for the second crop can't make up entirely for the poor utilization of nitrogen in the season the nitrogen application is made.

It's obvious from the above yield data that returns will diminish as increasing amounts of nitrogen are applied. The most corn per pound of nitrogen was obtained from the first 40 pounds of nitrogen, less from the second 40 pounds, and still less from the third 40-pound increment.☆

SETTING COTTON CULTURE FREE FROM THE HOE

■ USDA-Mississippi experiment station research shows that herbicides and flaming can be an economical and effective means of controlling weeds in cotton. Over the past 6 years, the combined practices cut labor 70 to 80 percent. These practices, however, did not cut total cost significantly.

These practices drastically reduce the usual summer hand-hoeing and cultivation that create a peak demand for labor when it's needed for other crops. Releasing labor should give many planters the opportunity they have wanted to diversify their farming programs with such enterprises as forage-and-livestock farming.

Many growers have mechanized their operations except for weed control, only to find that they're still dependent on having a relatively large labor force. Partly mechanized cotton production doesn't adequately utilize that labor. In wet seasons, the peak demand for labor is all the greater, and wages higher due to the demand. Wet weather prevents tillage and gives weeds a head start. This occurs often in the Southeast.

The last 6 years at the Delta Branch Experiment Station, Stoneville, ARS and State researchers applied 3 herbicidal-oil sprays at intervals of 5 to 8 days, starting when the cotton was 3 inches tall, and following up with 2 or 3 flamings. This gave effective, economical weed control and reduced labor considerably. The additional practice of applying a 12-inch band of the preemergence-type herbicide CIPC over the row while planting practically eliminated hoeing. This not only kept down weeds effectively for 6 to 8 weeks but also made a big saving in labor, though little or none in the cost of weed control.

In some of the test years, low rainfall reduced the weed problem but not the cost of chemical treatment. However, the rather costly preemergence spray insured the cotton crop, year in and year out, against the occasional weedy conditions that prove so troublesome and costly in rainy seasons.

Using post-emergence oil sprays and flaming cut cost as well as labor, but the introduction of a preemergence spray with CIPC cost a little more than the labor it displaced.

Both spraying and flaming are precision controls to be used only in the prescribed way and under suitable conditions. In some situations, these practices will injure the cotton or fail to control weeds. State experiment stations are good sources of information on the desirability of adopting a spray-and-flame program for weed control on a specific farm.☆

DOUBLE CROPPING . . . Why and How

Work in two Southern States has brought some practical advances

SOUTHERN farmers should find substantial advantages in double cropping soybeans and small grain according to methods devised by cooperative USDA-State research.

Six years of trials in the North Carolina Coastal Plain and Mississippi Delta regions have demonstrated the feasibility of double cropping. These tests also show a need for improved ways of carrying out the practice.

Methods used the last 2 years have given good results in reducing soil-preparation costs, conserving moisture in sandy loam or heavy clay soil, providing stands when rainfall is short, and discouraging weeds.

In the North Carolina double-cropping experiments, soybeans were planted following wheat harvest, usually about mid-June. This runs well past the recommended single-crop planting season of May 1–20.

Plantings were made by a till planter that placed seed and fertilizer in one operation, according to ARS agronomist C. A. Brim. Three methods of planting without plowing were used: (1) over straw and stubble left by the combine, (2) over shredded straw, and (3) over fields on which stubble had been mowed and all straw removed. The first caused frequent stoppages when the machine encountered heavy stubble or straw left in the windrow by the combine. Use of a straw spreader lessened this difficulty, and stoppages were reduced to a minimum when the straw was shredded or removed from the field.

Good comparisons between till planting without plowing and conventional planting were obtained in 1953 and 1954. In 1953, soybeans planted June 23, after plowing, yielded slightly less than 22 bushels for the Roanoke variety and barely 20 for Ogden. Yields were 22.4 and 21 bushels, respectively, under till planting July 1. In 1954, with little rainfall from 2 weeks before to 2 weeks after planting, it was necessary to irrigate the conventionally planted soybeans to obtain a stand. But till-planted beans produced good stands without irrigation. Yields of soybeans under both methods were identical.

Results of the double-crop plan show that when the second crop is planted as soon as possible after the first is harvested, yields of each crop are only slightly reduced from yields on plantings made at the optimum date for single crops. The combined returns from both are much better than from either as a single crop.

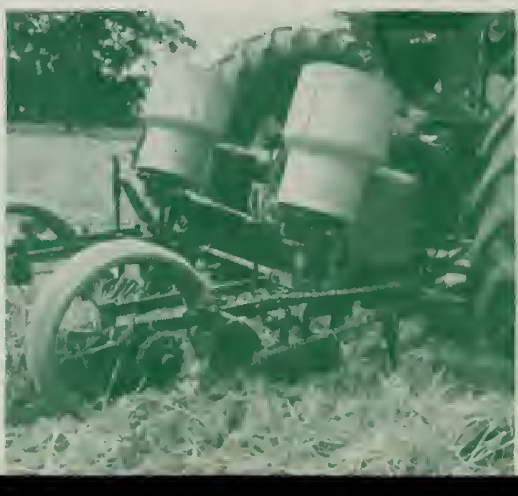
Another method of double cropping has evolved after 2 years of cooperative work at Mississippi's Delta Branch Experiment Station, at Stoneville. On heavy clay soils, a double-disc opener has replaced the conventional sword opener on the standard planter. The disc opener penetrates heavy clay soil. It permits placing soybean seeds in moisture so that plants emerge immediately without a rain and grow ahead of the weeds. With conventional planting methods on heavy clay soils common to the delta area of Mississippi, Arkansas, and Louisiana, a 1-inch to 2-inch rain is required after planting to insure a satisfactory stand of soybeans.

Because of the problem of getting stands, many growers have preferred to plant beans in early April when there's greater likelihood of rains. May plantings, however, will produce consistently better results than early plantings. Satisfactory stands can be obtained from use of the double-disc opener in May plantings.

ARS and implement-company engineers have modified the disc opener used in the original experiments, and a superior device will soon be commercially available. The double-disc opener permits planting soybeans in

TILL PLANTER used in North Carolina study features sweeps mounted ahead of the drive wheels. Sweeps break the soil without inverting it, shear off roots, mix residues with soil, and leave seed bed in good tilth.

REAR EQUIPMENT on the till planter opens, fertilizes, seeds, and closes the furrow. Fertilizer is placed below or at both sides of the seeds. Press wheel firms the row to make sure seeds get ample moisture.



SEED BEDS in a till-planted field are clearly defined and weedless. Residue from the previous crop forms a mulch between the rows that discourages weed growth, conserves moisture, and improves the soil condition.

small-grain stubble on heavy clay soils without seedbed preparation. Good results have been obtained when the straw was shredded or burned. Shredded straw provides a mulch that conserves moisture and tends to shade out weed seeds that germinate after shredding. Burning destroys weeds regardless of size—an advantage over the shredding process, which doesn't destroy weed seeds below the height at which the straw is shredded.

The Stoneville experiments, under ARS agronomist E. E. Hartwig, have shown that mid-June plantings can give bean yields ranging from 80 to 85 percent of yields from full-season plantings made at the optimum time in May. The May or June plantings grow more rapidly than April plantings and thus shade out weeds better. In addition, a small-grain crop has already been harvested.

Stoneville work has stressed time-of-planting and soil-temperature studies to develop cultural methods that would give delta growers full benefit of new varieties adapted for bean production in the South.

Three improved varieties—Dorman, Jackson, and Lee—have been released in the last 4 years under the soybean-breeding program in which ARS is cooperating with experiment stations in the 12 Southeastern States. Lee, newest of the three varieties, is resistant to some of the major soybean diseases common to the South (AGR. RES., June 1954, p. 12).☆

DOUBLE-DISK OPENER attachment for a planter is useful on Mississippi Delta heavy clays. Lead disks open moist furrow. Row is seeded, closed, and firmed. This method causes minimum disturbance to the surface.

SHARP CONTRAST shows up between healthy Ladino clover (left) and virus-infected plants in test plots. Yield loss ranges up to one-half. All plants had same parent.

What Virus Can Do

SURPRISING Ladino clover losses due to virus infection—losses up to half the yield—have been shown by K. W. Kreitlow, O. J. Hunt, and H. L. Wilkins at USDA's Agricultural Research Center, Beltsville, Md.

A preliminary greenhouse comparison was made of 320 healthy plants with 320 virus-infected plants. All plants came by vegetative increase from one healthy mother plant, so some plants could be infected artificially with virus and the others kept healthy. In a preliminary 1-year study, virus reduced yield in 2 harvests by 48.4 percent on the average. In field plots, virus reduced yield of Ladino clover from this same plant source 40 percent, and from another plant source 54 percent.

This will doubtless shock farmers who generally graze Ladino clover—thus don't know what their plantings yield with or without the virus.

On casual observation, many virus-infected plants showed no visible symptoms, although tests proved them infected. This was expected. But it came as a surprise that these plants, despite normal height and appearance, yielded about the same as stunted ones that obviously were infected. Though the plants lost nothing in height, they lost much through sparser growth. That's why a look at the pasture often deceives.

Diseased plants in the outdoor plots didn't spread as rapidly as healthy ones during the summer and fall. And winter weather may take a substantial toll. These factors will affect plot-yield comparisons to be made again next summer. The scientists will also repeat the yield comparisons between equal numbers of plants to determine whether additional weakening has occurred to further affect the yield-loss rate.

Analysis of the diseased and healthy plant materials showed some significant chemical differences—more crude protein and nitrogen-free extract and less crude fiber in the diseased plants. Wilkins thinks the added protein may be partly virus material, which is itself a protein-like substance. But the apparent bonus in certain constitutents within virus-infected plants is drastically offset by the drop in yield.

These figures don't tell anything about the quality of the nutrients that were increased by the disease—how much of them is digestible and what effect the diseased plants have on animal growth and health.

Larger-scale studies are needed to check these preliminary results and to learn more about their significance in animal nutrition.☆

Find out with CHROMATOGRAPHY

This versatile, sensitive technique is helping scientists do some difficult jobs

TRANSFORMING plentiful harvests into industrial raw materials and new wealth is one aim of agricultural research. And our research progress depends heavily on having effective techniques.

The first step in the development of new uses for a farm commodity is an exhaustive study of its composition. Scientists accomplish this by isolating the components, determining their chemical and physical properties, and evaluating their prospects for use in industry.

Today, one of the most versatile and sensitive techniques for separation, purification, and identification of substances is chromatography. With it, scientists have isolated and identified amino acids, flavoring agents, pigments, vitamins, hormones, drugs, fatty acids, and myriad other substances. And it is helping trace the steps in photosynthesis by which a plant turns the sun's energy into food—a monumental advance in our understanding of the processes of life and reactions in living cells.

We have reported the contribution of chromatography in isolating a new chemical from pine-gum rosin (December 1955, p. 14) and in disclosing what plants make with soil-derived minerals (October 1955, p. 3).

This tool has also brought striking advances in many other areas.

In work on insecticides, researchers use chromatography to isolate the active principles of plants known to be poisonous to insects. Scientists may then be able to synthesize these principles and make a compound toxic to insects. Another interesting adaption has been isolation from the female gypsy moth of the substance that attracts male moths. Development of synthetic attractants for insect control should follow.

In tobacco research, chromatography separated compounds that could not be distinguished from nicotine by other analytical methods. This enables breeders to select parent strains free from undesired alkaloids.

In plant and animal diseases, chromatography is providing information needed to synthesize new compounds for the control of these diseases. It's helping select breeding materials resistant to the viruses.

The technique is helping researchers to find out what occurs in fruit browning and to devise practical ways of retarding deterioration.

We are assembling a large body of useful information on the composition of farm products at every stage from harvest through processing.

In other studies, agricultural scientists combine chromatography with radioactive tracing techniques and other methods to follow the uptake and movement of growth regulators like 2,4–D through plants.

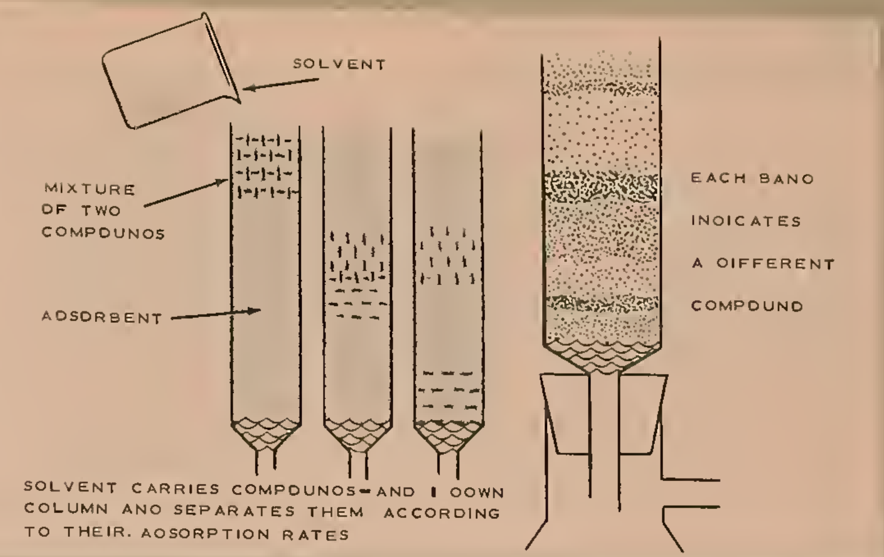
Gas chromatography is separating volatile components in aroma of baked bread, strawberry essence, lemon oil, and roasted poultry. This is essential in learning how to stabilize and preserve these flavors.

As to the technique itself, chromatography uses adsorption—the adhesion of a thin layer of molecules of a solid, liquid, or gas to the surface of a solid body. There are three broad types—column, paper, and gas.

Column

• COLUMN chromatography uses finely powdered adsorbent in a vertical glass column. This is called Tswett's column after botanist Michael Tswett, who devised chromatography while separating leaf pigments. When a solution is filtered through this column, pigments separate from top to bottom into various colored bands—a chromatogram. Isolation is completed by pushing column out of tube, cutting apart colored bands, and extracting each purified pigment with a solvent.

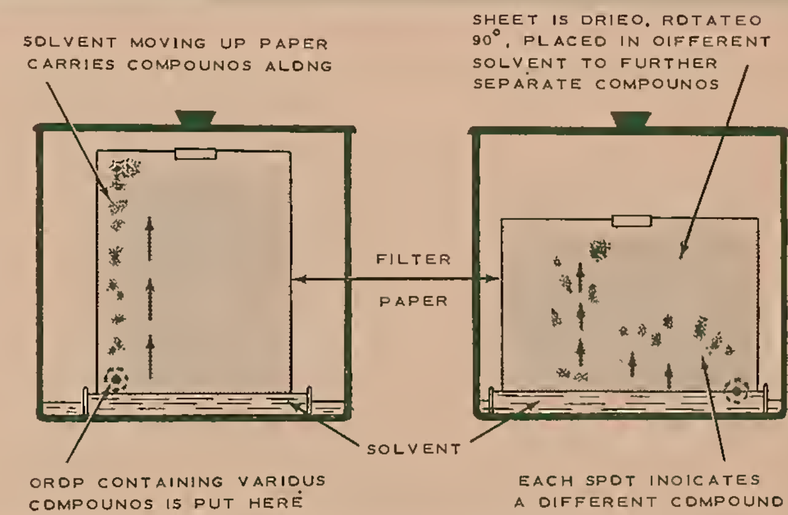
Bands are obvious when colored, but a physical or chemical method must be used to distinguish components of a colorless substance. A suitable solvent will carry these parts through column—weaker adsorbed ones move off first. Solution is collected in small samples. Identification can be made by ultraviolet light if components have fluorescent colors, a Geiger counter if they're radioactive, bioassay if they're biologically active, chemical reagents if the components react to produce colors.



Paper

• PAPER chromatography is the most popular of all because of its simplicity and great sensitivity. The separations are carried out on strips or sheets of paper instead of on an adsorbent in a glass tube as in the column type. A small drop of the sample containing the substances to be separated is applied a short distance from one end of the filter paper. The drop is allowed to dry, and the end of the paper nearest the spot is placed in the solvent or developing solution. The solvent moves past the test spot by capillary action and carries the components along the paper, where they separate out from each other according to their relative solubility in the solvent.

In "two-dimensional" chromatography the sheet is then dried, rotated 90°, and the edge nearest the sample drop inserted into a second developing solvent. Thus, the second solvent moves onto the sheet perpendicular to the direction of the first. This further separates the component parts so they can be easily identified.

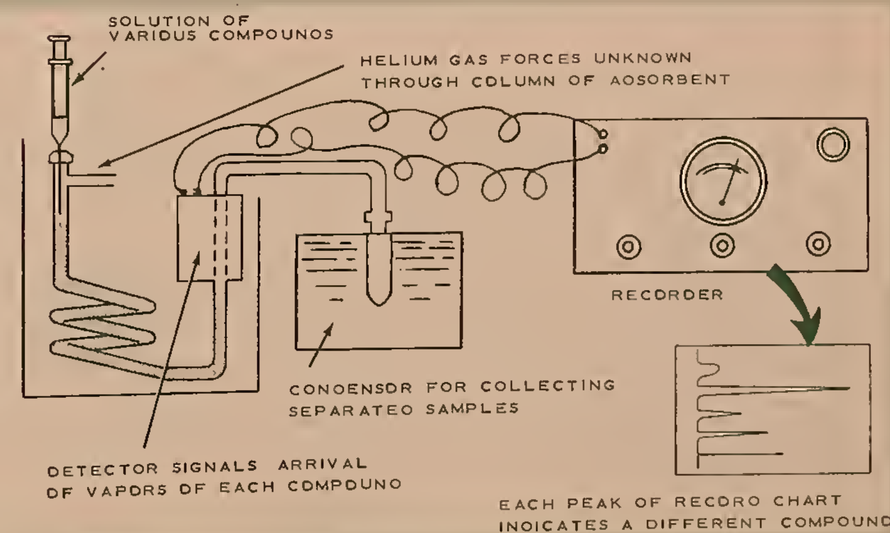


Gas

• GAS or vapor-liquid phase chromatography is radically different from the others and, where applicable, has great advantages of speed and accuracy. It has separated liquids with boiling points only one-third of a degree apart. Main limitation is that compounds must be volatile—they are separated in vapor instead of liquid form.

This process takes place in a tube several feet long. Tube, packed with adsorbent such as silica gel or alumina, is surrounded by jacket held at constant temperature by circulating liquid or vapor. Sample to be analyzed is forced through column by gentle stream of gas—helium, nitrogen, hydrogen, or carbon dioxide. Components vaporize and gas drives along the successive vapors. Components separate at different rates, according to their vaporization rate and their solubility in the adsorbent.

In setup shown, a sensing element signals the arrival of each component at the end of the column and a corresponding notation is made on a continuous recorder.



Guides ON MILK DRYING

STUDY SHOWS RECOVERY RATES, RANGE IN PROCESSING EFFICIENCY FOR NONFAT DRY MILK SOLIDS

HOW MUCH nonfat dry milk solids (*nfdms*) is a milk-drying plant likely to produce from the milk it processes? How efficient are the processors in recovering the solids?

Now, for the first time, USDA research has analyzed industry operations to answer these questions. The skim-milk-drying experience of 12 drying plants scattered through New England, the Midwest, and the West has been analyzed for a total of 112 days—from 3 to 16 days per plant. Here are some of the findings:

The industry turns out an average of 8.98 pounds of *nfdms* per 100 pounds of skim milk dried. (This includes a small amount of sweet-cream buttermilk that plants mixed and dried with the skim milk. The buttermilk poundage was converted to skim milk equivalent for calculating yield. Otherwise, the milk processed was essentially that remaining after separating out cream of about 40-percent fat for butter making.)

Average composition of this 8.98 pounds of *nfdms* was 8.63 pounds of nonfat solids, 0.07 pound of fat, and 0.28 pound of moisture. The skim milk actually contained 9 pounds of nonfat solids and 0.08 pound of fat. Thus, on the average, the drying plants were 96 percent efficient in recovering the solids. Individually, processors ranged from 89 percent to nearly 100 percent efficient in removing solids.

Losses of skim-milk solids in drying averaged about 4 percent regardless of the process used—spray or roller drying. Losses were at about the same level whether the plants received whole milk or skim milk to process.

The recovery figures from this study are reasonably good yardsticks for any plant's long-run operations or for a large group of plants for any one day. But there's likely to be considerable discrepancy when the figures are applied to a single day's operations in a single processing plant.

A number of previous studies have indicated some relationships between butterfat content and nonfat-solids content of whole milk. This study showed that there's a consistent relationship between butterfat and the industry's average yield of *nfdms* from milk originally testing between 3.5 and 4.1 percent fat as whole milk.

The outturn averaged 8.76 pounds of *nfdms* per hundredweight of skim milk when the whole milk tested 3.5 percent fat. For each 0.1 percent increase in fat test, on the average, an additional 0.05 pound of *nfdms* was recovered from the milk.

According to agricultural economist A. G. Mathis, of Agricultural Marketing Service, this study affords the first comprehensive published information that can be used to estimate expected yields of nonfat dry milk solids. Such estimates give farmer members of cooperatives and plant management a basis for determining the efficiency of their drying operations. Bargaining cooperatives and milk-market administrators can also use the estimates as a basis for verifying the reported usage of milk sold under classified-pricing plans.

A fuller report is being made by Agricultural Marketing Service.☆

DRYING PLANTS differ widely in the amount of solids they remove from skim milk. On average, plants recover 96 percent of the total.

SURVEY DATA show relation of butterfat percent in whole milk and the yield of solids from drying skim milk left from butter making.

Butterfat in the Whole Milk	Expected Outturn* of Nonfat Dry Milk Solids per 100 Pounds of Skim Milk Left after Removing 40-Percent Cream	
	Average	Range
percent	pounds	pounds
3.5	8.76	8.58 --- 8.94
3.6	8.81	8.63 --- 8.99
3.7	8.86	8.68 --- 9.04
3.8	8.91	8.73 --- 9.09
3.9	8.96	8.78 --- 9.14
4.0	9.01	8.83 --- 9.18
4.1	9.06	8.88 --- 9.24

*From 95 percent of the runs.

HOW TO MAKE GOOD FRENCH FRIES

Many factors from field to fat influence their quality

YOUR appetite won't be whetted by words like time, temperature, and specific gravity. But they mean the difference between grease-soaked, dark-brown, scorched-tasting french fries and those with a crisp, golden-brown surface and mealy centers.

Several commercially important varieties of potatoes from locations ranging from Maine to Washington have been studied by USDA food specialists and plant physiologists. They have found that best french fries come from potatoes of high specific gravity—the heaviest for their size.

Previous research has shown that high specific gravity potatoes are also best for baking or mashing and for potato chips. This suggests that potatoes may some day come to market labeled according to the cooking method for which they are best suited (AGR. RES., January 1955, p. 14).

Though specific gravity is important, tuber storage temperature also plays a part in french-fry results.

Ordinarily, potatoes are stored at 40° F. to retard shriveling and sprouting. But this temperature fosters in potatoes a chemical action that changes starch to sugar. High sugar content in the tubers results in getting scorched-tasting, overly brown french fries, the specialists explain.

Storage temperatures of 50°, 55°, and 60° F. retard sugar accumulation and give french fries of good flavor and color. Even at 45° F. storage, sugar accumulation is lessened. And potatoes remain firm for 3 to 4 months when stored at 45° and 50° F., though some sprouting occurs.

For potatoes that must be held longer than 4 months before frying, the specialists experimented with storage at 40° F., followed by "desugaring." (Desugaring, a process potato chippers use, calls for holding tubers at warm temperatures for a short time. This causes the chemical action in the potato to reverse and the sugar to change back to starch.)

Research showed that potatoes stored at 40° F. gave best french fries when desugared for 2 or 3 weeks at 70° F. Some varieties—Green Mountain and Triumph, for example—build such a high sugar content that desugaring doesn't help much.

Quick washing of pared and sliced potatoes to remove surface starch gave mealier french fries than soaking potatoes in water for 10 minutes before frying. During soaking, potatoes absorb water, which makes the raw slices crisp. But that same water must be cooked out in frying, which slows down cooking and tends to increase oiliness and sogginess.

An 8-to-1 weight ratio of fat to cut potatoes was found to give best frying results. This prevents a large drop in the fat temperature when the potatoes are added and makes sure that the fat quickly returns to its original temperature. If there is a large temperature drop and slow return to cooking temperature, potatoes will absorb too much of the fat.

Par-frying during slack times and holding the partially cooked potatoes at room or refrigerator temperature to be "finished off" at meal time is a practice restaurants often employ. It was found to give less tender but satisfactory french fries.

The specialists point out that par-frying and holding can be a convenience to the home cook as well as the restaurant chef. Par-fries may be held as long as 4 hours at room temperature or 24 hours if covered in a refrigerator. To be held a longer time, however, par-fries should be frozen and stored at 0° F.

Best temperature and time for par-frying 3/8-inch potato strips—the usual thickness—was found to be 360° for 4 minutes or until the potatoes are an opaque white. The finishing off should be done in 375° F. oil until the strips are golden brown.

If newly harvested potatoes are par-fried, they can be held in freezer storage at 0° F. up to 9 months and be as tasty and tender as freshly prepared french fries, it was found.

Even raw tubers stored as long as 3 months before they are par-fried and frozen will finish into good french fries. But mealiness of french fries declines slightly when frozen par-fries are made from raw tubers that have been stored 4 months.

Frozen par-fries can be finished successfully by simply placing them in the oven. Except for a slight decrease in tenderness and less uniformity of browning, frozen par-fries heated in a 500° F. oven for 10 minutes, or in a broiler at 500° F. for 5 minutes, compared favorably with those browned in deep fat.

USDA Technical Bulletin 1142, "French Frying Quality of Potatoes as Influenced by Cooking Methods, Storage Conditions, and Specific Gravity of Tuber," gives details. Authors of the bulletin are M. E. Kirkpatrick, B. M. Mountjoy, and C. E. Falatko, ARS; P. H. Heinze and C. C. Craft, Agricultural Marketing Service.☆

food and home

Tools FOR NUTRITIONISTS

Another USDA food table—one on yields—will be issued soon

USDA food-composition tables for various nutrients or classes of foods have long been standards of reference. The values, revised from time to time, are used in textbooks on nutrition and dietetics and by food and nutrition workers, the medical profession, food industries, and a number of governmental agencies.

There is, for example, Agricultural Handbook 8, "Composition of Foods—Raw, Processed, Prepared." Summarizing data available up to 1950, it is still the basic reference on calories, protein, carbohydrate, fat, and certain minerals and vitamins.

But production and processing practices are constantly changing food products, necessitating a review or re-evaluation of past summaries. New constituents are discovered, or old ones receive different emphasis because of research findings. The nutrition analysts continue to collect data to keep abreast of these developments and, as new data accumulate, revise and publish new tables.

Sometimes supplementary data are collected to meet a special need. Among these was a food-composition table for the Armed Forces. Another table dealt with the composition of foods used in Far Eastern countries, for those concerned with diets or food supplies of that part of the world.

Often, information on a special group of constituents is summarized and published—as in AH 74, "Energy Values of Foods—Basis and Derivation," issued in 1955. A technical presentation intended primarily for professional and research workers, it shows in detail the basis of the energy values in Handbook 8. Most calorie tables use figures derived as explained in Handbook 74. Another publication brings together figures on folic acid—essential data for physicians who are working on anemia.

A study now in progress will provide data on the better known amino acids in some 300 foods. In preliminary stage, some of these figures have already been put to use by USDA and by an Expert Committee on Protein Requirements set up by the United Nations' Food and Agriculture Organization. H. K. Stiebeling, ARS director of home economics research and a member of this committee, supplied the data on amino acids as a basis for estimating how to use foods effectively in fulfilling protein needs.

Another table, soon to be published, is "Food Yields—Summarized by Different Stages of Preparation." It shows how much the meat, fruits, vegetables, and other foods purchased in the market can be expected to yield as food ready to eat.

This information on yield and different kinds of preparation loss will help dietitians and food managers gauge quantities in the course of planning food purchasing for school lunchrooms, hotels, and restaurants, for the Armed Forces, and for hospitals and other institutions. Home economists and family food managers will use the table in preparing food budgets and market lists when getting most nutritive value for money spent is all important. Researchers also need to know food yields when computing nutrients in foods as eaten, in making nutrition or dietary surveys, or in evaluating diets.

USDA nutrition analysts for the past 60 years have provided general figures for estimating food yields, as part of the overall study on food composition. But this is the first time that such figures have been brought together in a special tabulation.

In compiling this table, the nutrition analysts made a special search for data originating in the United States since 1940. Newer data reflect present-day marketing practices of trimming vegetables and prepackaging produce and meat, as well as the effect of new varieties and breeds. More detail is given in this publication on the amount of refuse—pits,

bones, shells, skins—and of waste due to spoilage and trimming than was reported years ago. Moreover, many of the recent data have been collected under practical working conditions in institutions and private homes, and more nearly represent present-day products and practices than some of the earlier figures published.

New also are figures on weight losses and gains during cooking—evaporation and drippings in meats, evaporation in vegetables, and absorbed water in cereal products.

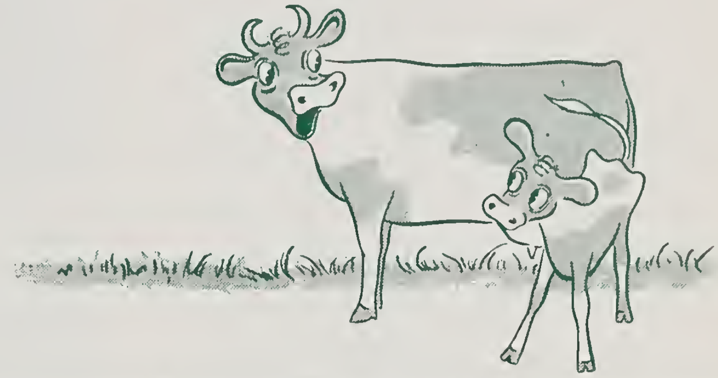
Yield data came from many sources. Some are byproducts of ARS work planned for other purposes—chemical analysis of foods, canning, dehydration, and freezing, development of recipes, and household use in relation to quality. Marketing studies to determine yield of meat cuts and poultry supplied data, as did the Armed Forces boneless-beef study (AGR. RES., March 1956, p. 15).

Other figures came from experiments of the Fish and Wildlife Service on methods of processing and cooking fish, from Navy studies on fresh and processed vegetables, and from work in the Food and Drug Administration, universities, and experiment stations. Meat-packing houses and other commercial and industrial concerns contributed a great deal of data.

The compilers ran into many problems—in some cases the nutrition analysts felt that the number of food samples was not large enough to give reliable averages—especially of bone, skin, and other losses in meats after cooking. A few foods are not listed at all because there are no data available on them at the present time.

To fill these gaps in data on physical yields—as well as others on nutrient content of foods—ARS invites researchers to send in data on composition as work is completed. Food composition tables will be revised from time to time as more and better data become available.☆

LOW-PROTEIN DIET—UPSET REPRODUCTION?



Preliminary results indicate that the lack of protein cuts quantity and quality of the calf crop

EFFECT of a low-protein diet on cattle reproduction is being investigated at USDA's Agricultural Research Center, Beltsville, Md.

Positive findings by ARS scientists should explain why small calf crops are frequently experienced by beef producers in various areas where natural feeds are low in protein.

Feeding tests conducted since 1951 under cattle nutritionist R. E. Davis have thus far provided no conclusive results but do indicate that lack of protein may upset normal reproductive functions in cows.

All cows are kept continuously on the experimental rations and are rebred as soon as possible after calving. Experimental evidence to date indicates that cows receiving the low level of protein do not come into heat as soon after calving as do those on the higher protein level. And the interval between calvings is longer. There is also limited data showing that the duration of heat is shorter than normal. These possibilities are now being further investigated by periodic examination of the ovaries of all cows in the experiment. Either delayed or short estrus periods, especially in large beef herds, could easily be an important factor in receiving a below-normal crop of calves.

In results obtained so far, a second striking effect of the low-protein ration is a decrease in weight of calves at weaning time. Birth weights, the tests have shown, are not significantly different between calves from cows fed a very-low-protein diet and those fed a recommended minimum-protein diet. But the calves from the low-protein group have averaged 40 or more pounds lighter at 6 months of age (weaning) than those that were produced by the control group.

Cattle used in the experiments are Milking Shorthorns crossed with Herefords. The control group was fed approximately 0.9 pound of digestible protein per animal daily—the minimum recommended level. The low group gets two-thirds of this amount, or 0.6 pound per animal. Protein in both diets is adjusted by the quantity of alfalfa pellets used.

Except for the difference in protein, feed given both groups supplies the same total digestible nutrients and provides the recommended amount of energy. This feed is composed of

corn-and-cob meal, salt, vitamin A, and bone meal. In addition, cows in both groups are fed low-protein grass hay. (The hay and the grain are weighed for each cow daily.)

The feeding plan used requires that the cows consume their hay rations before they get their grain rations. And the quantity of hay each animal eats determines the amount of grain-protein feed she will receive. A cow consuming 15 pounds of hay, for example, gets 9 pounds of grain and supplement. The cows used in both groups are kept in confinement and do not have access to pasture.

The low-protein animals probably get more protein than some cattle get at certain seasons in some protein-deficient areas. These experimental cattle are maintained at constant levels of protein all year.

Davis and his coworkers do not expect such striking results from the experiments as these scientists obtained in work on vitamin-A deficiency. (Those tests were conducted over a period of 12 years. It was found that cows given a daily allowance of 30 micrograms (approximately one ten-millionth of an ounce) of beta carotene per kilogram (2.2 pounds) of body weight, rarely gave birth to living calves and none lived to weaning age. Some cows receiving 60 micrograms bore calves, but many of these were weak. Ninety micrograms gave good results. But to assure adequate quantities of vitamin A under any condition, 120 micrograms of beta carotene per kilogram of body weight was recommended as the daily minimum for cows.)

The importance of this protein-productivity study, however, is best indicated by the fact that use of protein supplements in some low-protein areas has not increased calf crops to the desired level. The present work may show the kind and amount of protein needed, as well as the best time and method of supplementation, to increase our calf crop.☆

HERD SIRES at Miles City have proved their worth, are replaced only when their production records are topped by those of younger bulls of the same experimental line.

FEED is weighed for young bull on a rate-of-gain test. With a good record, he may be given a breeding tryout.

GRAIN is weighed for the young bull. If he's chosen for breeding use, offspring will be given similar test.

POTENTIAL sire gets fed. Goals are ability to gain, efficient feed use, milking ability, and carcass quality.

TURNING FEED INTO BEEF

Montana research means better-quality, more-efficient cattle

RAPID gains and increased ability to convert feed to high-quality beef on the range or in the feedlot are results of research underway at the United States Range Livestock Experiment Station, Miles City, Mont.

ARS researchers, in cooperation with the Montana experiment station, are following a program of inbreeding and continuous production testing to determine their progress.

Selection and line breeding over a period of 20 years has enabled researchers to increase the average performance level of many of the desirable characteristics that make for efficient beef production in individual animals or specific lines of cattle.

A 10-year comparison of steers, sired at the station by a single line of inbred bulls, stands out as an example of the degree to which such characteristics can be improved.

Four groups of steers, started in the feedlot at weaning weights averaging 442 pounds, gained an average of 1.99 pounds daily, weighed 904 pounds out of the feedlot, and ate 586 pounds of grain for each 100 pounds of gain. Ten years later, another group of steers sired by a bull of the same inbred line was checked. They averaged 456 pounds at weaning, gained 2.48 pounds daily, weighed 1,064 pounds out of the feedlot, and used 593 pounds of grain for each 100 pounds of weight put on.

In both cases, the steers were calved in April, weaned in October, and fed for the same length of time on the same rations. The daily gain for the latter group was 25 percent greater and the final weight 160 pounds more per steer. The slightly greater quantity of feed used by the latter group of animals is chargeable to the usual reduced feed efficiency that develops in cattle as fattening increases.

Breeding work began at the station in 1934. Since then, 11 lines have been established and maintained, 3 others having been discarded because of undesirable characteristics.

Production tests of the lines retained are made in two ways as the work progresses. Potential sires are tested for their gaining ability and feed efficiency, and those selected are bred to grade cows. A random sample of each sire's progeny is likewise tested. Steer calves are raised to about 15 months, when evaluations are made as to the merits of each animal—alive and in the carcass. These evaluations reflect for or against the herd sires in each experimental line.

Each of the 11 lines of purebred Herefords represents a closed herd in which no outside blood is introduced once a line becomes established. A herd sire in any line is replaced only when his production record (sire index) is surpassed by that of a younger sire of the same line.

Production tests of sires and progeny have served to prove the high degree of heritability of the ability to gain. Sire and steer records of gain have been strikingly similar.

In feeding tests one year, for example, a line-10 bull ranked first among 7 being tested, with a gain just short of 3 pounds a day. Steers from the same bull also ranked first the following year, their daily gain averaging 2.66 pounds. In no case were progeny better or worse than their sires by more than one rank.

Research at Miles City is also directed toward developing at least two other important characteristics aside from the ability to gain and use feed efficiently. These are milking ability and carcass quality of the stock.

Like ability to gain, neither of these characteristics can be judged accurately by selecting animals for thickness of fleshing, body type, and uniformity. These factors have been emphasized in the past and are still useful in selecting for desirable characteristics. Much improvement can be attributed to their use. But they don't tell the whole story.

Milking ability is as important in beef cattle as in dairy cattle. Production testing helps to determine the adjustment that should be made, up or down, through breeding and selection to reach an optimum. Heavy production of milk in a range cow is about as undesirable as too little production because it frequently results in damage to part of the animal's udder.

The big test of breeding work comes in carcass studies of the individual progeny of breeding stock. These studies determine the actual quality of the beef produced—meat in relation to fat and bone, size of the eye muscle and the length and breadth of the loin, marbling of the lean with fat, and all the other quality factors that cannot be accurately determined by the examination of live cattle.

This research has served not only to bring out the more desirable characteristics but also to reveal and eliminate many of the undesirable characteristics in some lines.

Breeding work at Miles City has pointed up the need to start with top-notch foundation stock and continue with careful, continuous culling of animals to obtain the best results.☆

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agrisearch notes

ROOT-KNOT nematodes harm crops greatly on the Yuma Mesa of Arizona, but lightly in nearby Yuma Valley. USDA researchers think soil-texture difference may explain this.

The root-knot-susceptible plant hemp sesbania was grown in coarse loamy sand from the mesa, fine clay loam from the valley, and various mixtures of the two. This provided five gradations of texture from coarse to fine. All were heavily inoculated with the Javanese root-knot nematode that thrives on sesbania.

After 10 weeks, root galls ranged from a score of 3.6 (heavy infection) on coarsest soil to 1.5 (light) on finest soil. Plants also gained height with addition of clay, except for a slight reduction where mesa soil was omitted.

WATER IS AT A PREMIUM for growing wheat in areas of limited annual rainfall on the Great Plains. Yet, large amounts of water run off the fields during two periods of the year.

In a cooperative study by USDA and the Oklahoma experiment station, at Cherokee, Okla.. spring and summer storms had a lot to do with this water loss. Quite a bit of the 25-inch average annual precipitation occurs in the warm months and at peak rates up to 7 or 8 inches per hour for brief periods. The cycle runs about like this:

From July through October the ground is plowed and planted to wheat. Quite a few hard rains occur during this period, but they are intense for only brief periods. Nevertheless, runoff occurs during these intense downpours, even though the fresh-plowed land is quite absorptive. When the land is bare at that season, the storms cause a great deal of erosion. However, land that has been subtilled to leave stubble on the surface is much less susceptible to water loss and erosion.

Storms occur again with the return of warm weather in spring. Intense downpours last a little longer at this time—are much too hard to soak into the compacted soil readily. Rains coming before the wheat plants have made much growth cause considerable damage. As the season progresses, however, water tends to stand a while on the field, held back by the wheat which by then is fairly big. That retards runoff—especially in June when the storms are harder but the wheat larger. Ultimately, much water runs off but carries little soil with it.

We need cultural and cropping practices that will hold back that water until it can soak in. Researchers are working on this problem.

SPRAYING PLANTS—commonly associated with disease *control*—is being done in USDA experiments to *spread* diseases that kill sawflies infesting pine.

A virus found in a few diseased larvae of the Virginia pine sawfly 2 years ago was increased in the laboratory by infecting 5,000 of the insects. A preparation of this virus material sprayed on 38 sawfly-infested pines in Maryland last summer killed 77 percent of the sawflies within 11 days—up to 97 percent in one test.

The European pine sawfly also was controlled by test sprays of its own virus 5 years ago and in extensive tests since then. Both viruses proved effective against both sawflies, but each virus was more effective against its own special host.

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